

Complex Systems Lab

Biology 131

Stanford University, Fall Quarter 2013
Tuesdays, 2:15-3:45pm, Hewlett Teaching Center 102

Class Instructors:

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I. TOPICS: Classic experiments, simulations, and theory in Complex Systems.

II. READINGS: All required readings will be available on Coursework or Googledocs.

III. CLASS REQUIREMENTS: There are no prerequisites. This is a one credit satisfactory/no credit course. Credit will depend on attendance and class participation. Two absences are allowed, but will require a reading, modeling, and/or written assignment as make up. Additional absences must be excused.

IV. FORMAT: Classes will consist of lectures, discussion and hands-on exercises.

V. SCHEDULE:

Week 1 (sept 24): *Introduction to Complexity*

- Lecture: "Complex Systems"
- Syllabus distribution and overview of class topics

Week 2: *Deterministic Chaos*

- Video feedback experiment
- Mapping functions and attractors
- Netlogo simulation of mapping function
- Bifurcations

Week 3: *Chaos and initial conditions*

- Double Pendulum experiment

- Netlogo simulation of sensitivity to initial conditions
- Applications and extensions

Week 4: ***Fractals***

- The math of fractal dimensions
- Measuring fractal dimensions
- Fractals in Nature
- Applications

Week 5: ***Power laws and avalanches***

- The math of power law distributions
- Netlogo simulation of sand pile model
- Zipf's law
- Other applications

Week 6: ***Cellular automata***

- Cellular automata
- Netlogo model of Game of life

Week 7: ***Self organization***

- Netologo flocking model
- Crowd dynamics

Week 8: ***Emergence***

- Riots
- Netlogo model of segregation

Week 9: ***Networks***

- Small world network experiment
- Netlogo model of preferential attachment

Week 10: ***Complex systems in art***

- Complex systems in music
- Complex systems in print
- Complex systems in culture